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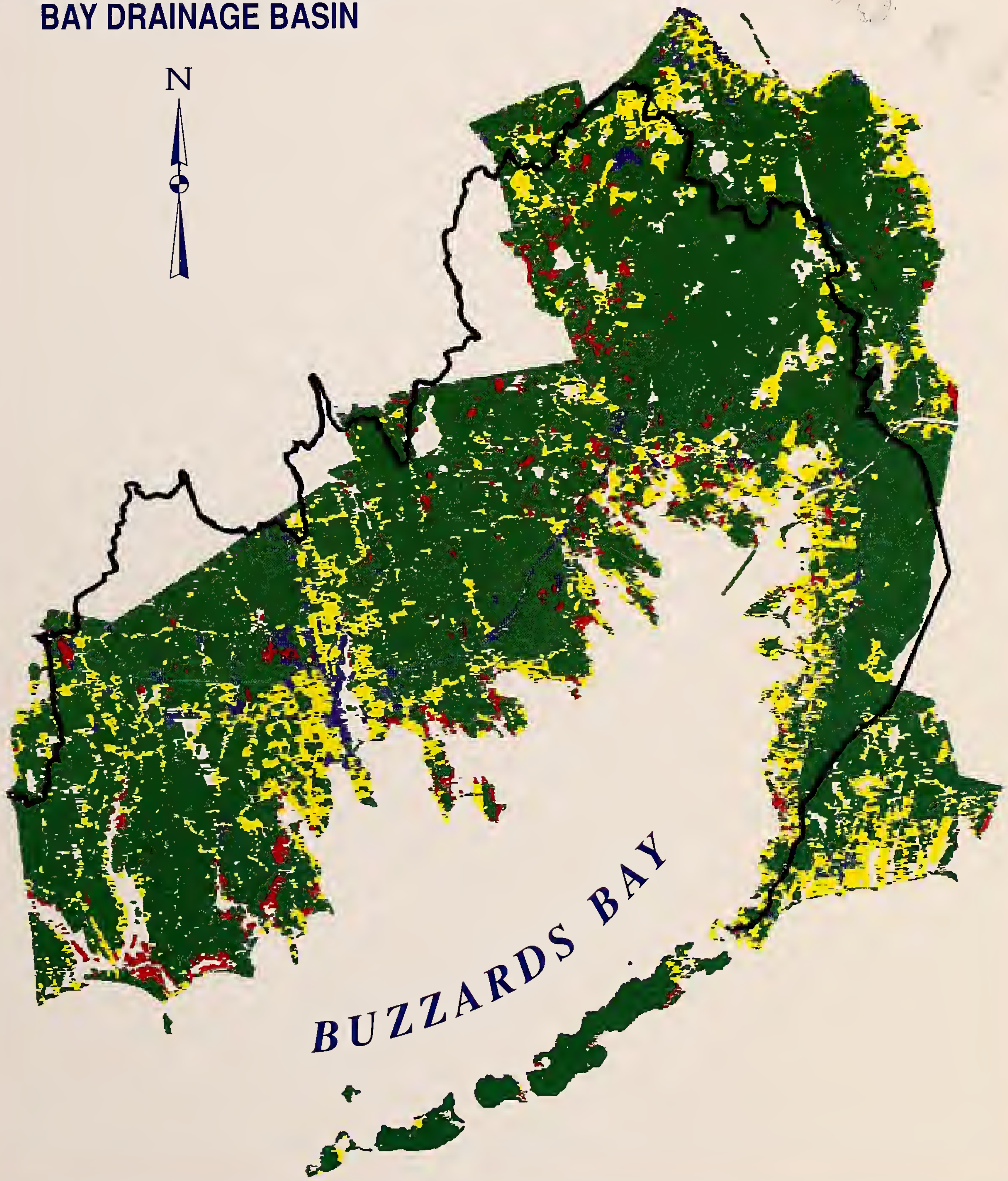
ANNUAL REPORT
1988 - 1989

LAND USE IN THE BUZZARDS BAY DRAINAGE BASIN



Blue
Urban, commercial, transportation, and waste-site land uses

Yellow
Residential land

Red
Salt marshes and freshwater wetlands

Green
All other land-use types

White
Coastal embayments, freshwater ponds and streams

Black line
Boundary of the drainage basin

BUZZARDS BAY PROJECT

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The Buzzards Bay Project
Annual Report
1988-1989

MEETING THE CHALLENGE

The Buzzards Bay Project is facing its greatest challenge to date. In the coming year it must develop a plan to manage the Bay and its resources in a way that will preserve and protect the Bay's waters and the plants and animals that live in those waters.

The history of the Project is marked with challenges met and mastered. The first was to encourage participation by as many of the Bay's users as possible. The Project's organization, structured around a series of committees, has succeeded in involving many different groups. Private citizens, environmental organizations, scientists, business people, and public officials from all levels of government have been given a voice in the Bay's future.

Another significant challenge has been to gather information about the problems facing the Bay and reach a consensus on which of these are the most pressing and important. This goal has been attained. There is now agreement on three priority issues — closure of shellfish beds due to pathogen contamination; nutrient enrichment leading to problems such as algal blooms and fish kills; and contamination of finfish, shellfish, and lobsters with toxic chemicals.

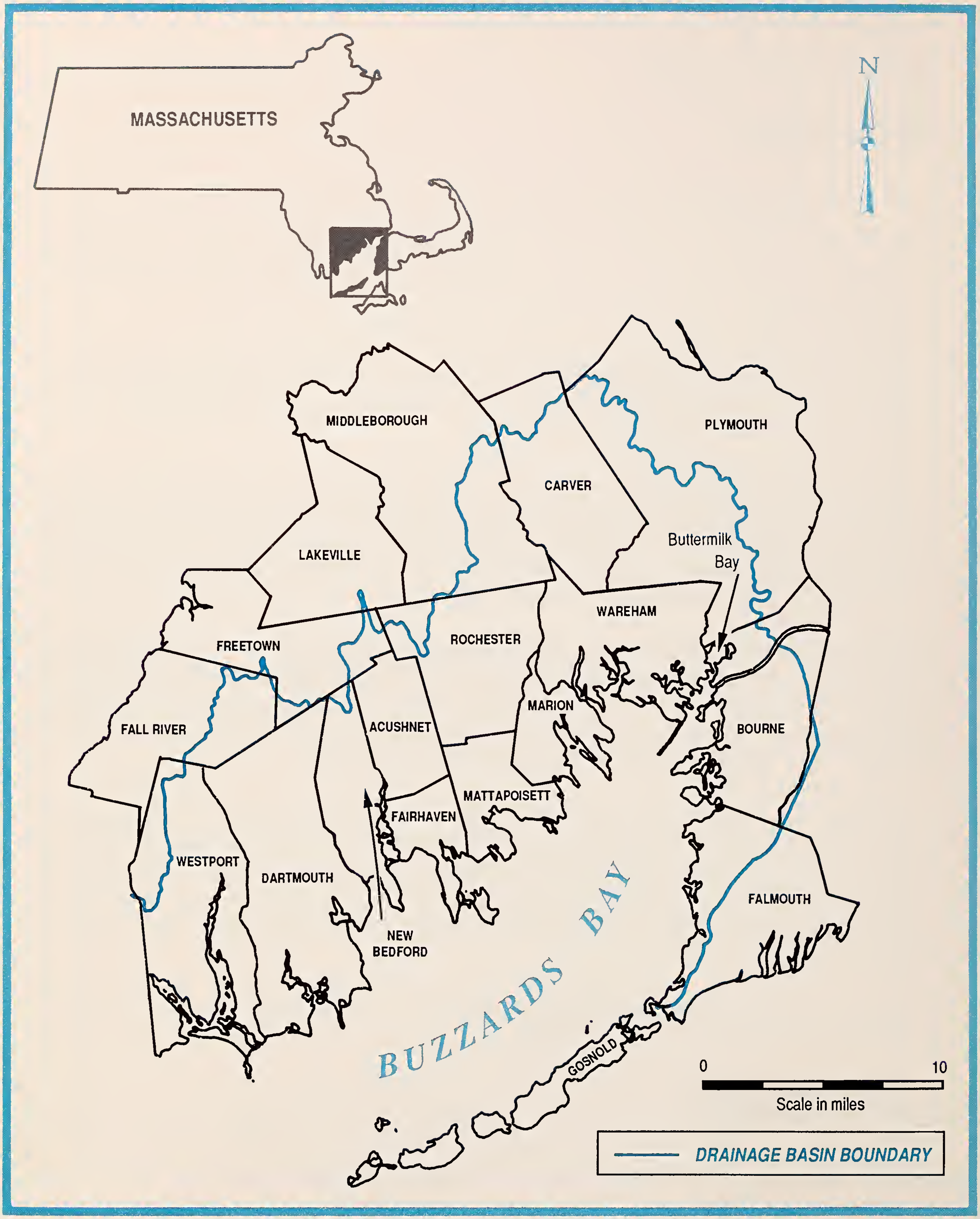
There were other challenges, too numerous to mention, along the way. But if the Project is to be successful, it must culminate in a specific, practical management plan that is put into practice. And without the help of literally hundreds of citizens in all the communities around the Bay, the plan cannot succeed. We must be prepared to support the provisions of the plan — whether they are as simple as using less fertilizer on our lawns or as complex as restricting development in sensitive coastal areas.

We are proud of the progress the Buzzards Bay Project has made to date. We urge you to continue to support the Project in meeting this challenge.

Julie Belaga

Julie Belaga
Regional Administrator
U.S. Environmental Protection Agency
Region I

John DeVillars
Secretary
Massachusetts Executive Office
of Environmental Affairs



This figure was prepared using data from MassGIS.
Computer assistance provided by EPA Region I GIS Office.

THE BUZZARDS BAY PROJECT IN PERSPECTIVE

Buzzards Bay means different things to different people. To some it is a place to swim, fish, or sail; to others it is a source of income from tourism; to still others it is a waterway for transport of goods. The land around the Bay is equally versatile — the site of homes, vacation houses, farms, business and industry.

Unfortunately, not all of these uses can coexist in harmony. Buzzards Bay, like many other coastal regions, is facing hard choices. As a society, we are discovering that we must identify our priorities. If we want shellfish uncontaminated by bacteria, are we willing to pay increased taxes for additional sewage and stormwater treatment? Is the pleasure of swimming in our bays enough to induce us to restrict residential and commercial development? Will we change our habits in order to have beaches free of waste? These decisions demand that we understand the problems and identify the solutions. This is what the Buzzards Bay Project is all about.

HISTORY OF THE PROJECT

The Buzzards Bay Project is one of the first estuary protection programs in the country. It began in 1985 under the joint management of the U.S. Environmental Protection Agency (EPA) and the Massachusetts Executive Office of Environmental Affairs. From the start, the Project had a threefold objective: (1) to set up a management structure, (2) to identify and research the priority water quality problems in Buzzards Bay, and (3) based on these findings, to draw up a management plan for the future protection of the Bay's water quality and valuable resources.

In 1988, Buzzards Bay was designated as an estuary of national significance in the National Estuary Program. As part of this unique program, the Project continued to fund research, monitoring, and management projects and to exchange information with similar projects across the United States.

During the past four years, local scientists have conducted research in and around Buzzards Bay. Based on their findings, the Buzzards Bay Project identified three priority problems: (1) closure of shellfish beds due to pathogen contamination, (2) eutrophication due to nutrient enrichment, and (3) toxic contamination of fish, lobster, and shellfish and the effects of this contamination on humans. These subjects are discussed in detail later in the report.

The Project is now ready to take results from many studies and apply them to actions. As part of the National Estuary Program, in 1990, the Buzzards Bay Project must develop a plan for managing the Bay. This plan, called the Comprehensive Conservation and Management Plan (CCMP), will recommend specific ways to preserve and enhance the Bay and its resources.

ABOUT BUZZARDS BAY

Physical Features

Buzzards Bay is a coastal embayment stretching between Cape Cod and Southeastern Massachusetts. The mouth of the Bay opens into Rhode Island Sound and the head has a man-made connection to Cape Cod Bay through the Cape Cod Canal. The Bay is 30 miles long; it has an average width of 9 miles and an average depth of 36 feet. The Bay,

The National Estuary Program (NEP) is a partnership of federal, state, and local interests aimed at preserving and protecting our nation's coastal resources. Congress established the NEP in 1987 with the reauthorization of the Clean Water Act. Through this legislation, important estuaries threatened by pollution, development, and overuse are targeted to receive funds and assistance for regional programs. These programs, like the Buzzards Bay Project, are charged with developing a plan for long-term management of the estuary's resources.

When it rains, much of the water runs across the land as surface runoff until it drains into a body of water such as a stream, river, or pond. The land that drains the runoff to the waterbody is called a watershed. Rain also percolates into the ground to become groundwater. Groundwater eventually makes its way to the sea through sediments near shore or by feeding into streams. The Buzzards Bay drainage basin is the land that surrounds the Bay and drains its surface water and groundwater into the Bay.

which was formed about 12,000 years ago when the glacier that had covered the area retreated, is characterized by a number of smaller, shallow embayments. One such embayment, Buttermilk Bay, has been extensively studied by the Buzzards Bay Project.

The drainage basin that surrounds Buzzards Bay covers approximately 400 square miles and is composed of 11 major sub-basins. Twelve rivers and many small streams flow into the Bay, but much of the fresh water that enters comes from groundwater, particularly on Cape Cod. Both streams and groundwater convey pollutants associated with land use. Wetlands — areas such as salt marshes and bogs that provide a transition between land and water — make up about 15 percent of the total land area in the drainage basin. Wetlands serve many valuable functions; they provide natural flood controls, offer habitat for a wealth of plants and animals, and act as a natural filter to keep pollutants from entering waterways.

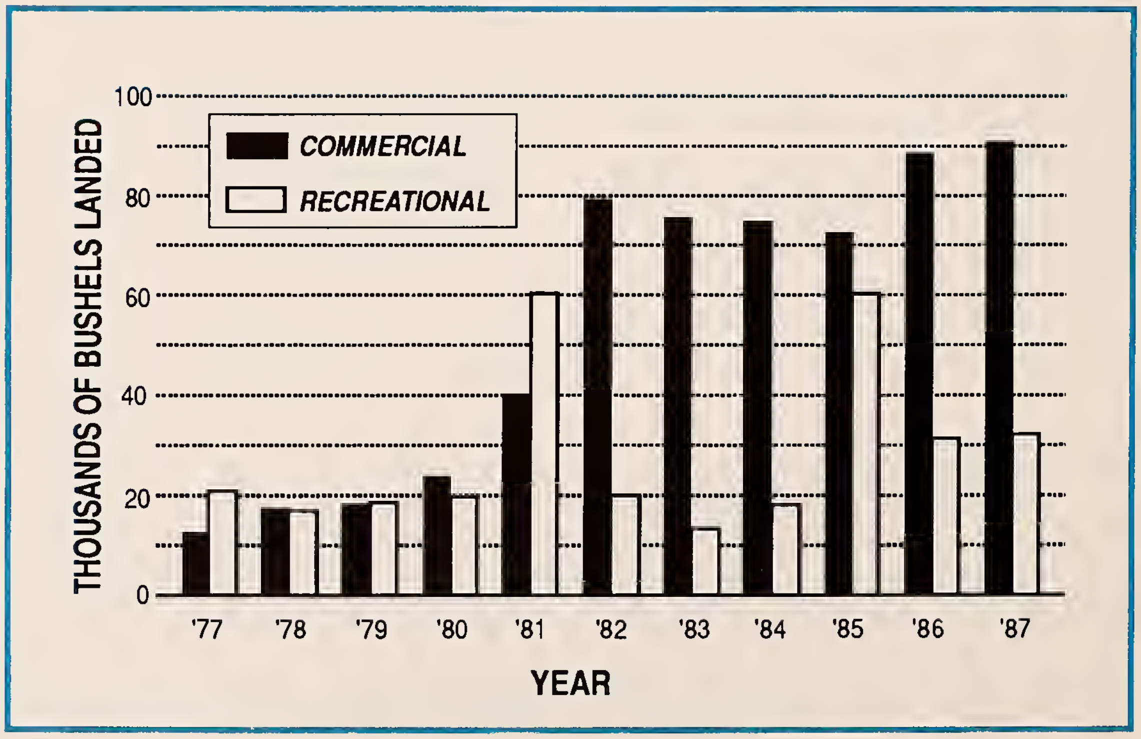
The Bay is home to a multitude of species. A variety of fish, including herring, bluefish, scup, striped bass, tautog, and winter flounder, are caught recreationally in the Bay. Shellfish, including the quahog, soft-shell clam, oyster, scallop, and mussel, are harvested from Bay waters. According to statistics from the Massachusetts Division of Marine Fisheries, commercial clammers landed about 90,000 bushels of quahogs in the Bay in 1987.

Geography

The Buzzards Bay drainage basin includes 17 communities in Bristol, Plymouth, Barnstable, and Dukes Counties in Massachusetts, as well as a small portion of Rhode Island. More than 250,000 people live in these communities and many more come as seasonal residents or visitors. The character of the communities varies from mainly rural to urban. Light industry, agriculture, and tourism form the basis for the economy of many communities surrounding Buzzards Bay. New Bedford is an important population center, manufacturing area, and fishing port. Last year fishery landings in New Bedford ranked as the second most valuable in the country.

The Southeastern Regional Planning and Economic Development District has compiled statistics on land use in the

QUAHOG LANDINGS FOR BUZZARDS BAY, 1977-87



Quahogs, or hard-shell clams, are caught both recreationally and commercially in Buzzards Bay.
Figure courtesy of the Massachusetts Division of Marine Fisheries.

New Bedford, the major population center in the Buzzards Bay drainage basin, has approximately 100,000 residents.

Photo courtesy of the Lloyd Center for Environmental Studies.

Buzzards Bay watershed.* For 11 communities lying wholly or with sizable areas in the drainage basin (Acushnet, Bourne, Dartmouth, Fairhaven, Falmouth, Marion, Mattapoisett, New Bedford, Rochester, Wareham, and Westport), figures were compared for 1951, 1971, and 1985. For all years, the greatest acreage was in forestland, followed by residential land. The other uses with the highest acreage were cropland, pastureland, and open land. Between 1951 and 1985, the largest numerical decrease was in forestland, followed by pastureland and cropland. Wetland, including inland wetland and salt marsh, also decreased. For example, salt marsh, both irregularly flooded and tidal, lost nearly 10 percent of its acreage. Most of this loss occurred before 1971.

The largest single increase was in residential land use, which rose nearly 100 percent. Land devoted to transportation also rose substantially, mainly as a result of highway construction. The third largest increase was in commercial land, with most of the rise before 1971. Since 1985, both commercial and industrial uses have been expanding rapidly.

Land use and Bay use affect water quality in Buzzards Bay. During the summer, more than 10,000 boats are moored in the Bay and many others are launched daily. The waste from approximately 135,000 people is discharged directly into Buzzards Bay from sewage treatment facilities and other outfalls. The rest of the residents within the Buzzards Bay drainage basin are served by on-site disposal systems such as septic tanks or by other land-based treatment facilities such as settling ponds or lagoons.

RELATIONSHIP BETWEEN DEVELOPMENT AND POLLUTION

Growth and Changes in Land Use

The communities around Buzzards Bay are growing rapidly. Towns like Dartmouth and Westport on the southwestern side of the Bay are changing from mainly agricultural communities to residential ones. The eastern side of the Bay is also experiencing growth and

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* *Southeastern Regional Planning & Economic Development District. June 1989. Land Use Changes in the Buzzards Bay Area, 1951-1985. Draft Report to the Buzzards Bay Project.*

To take one example of the problems associated with growth, in the past, houses built for seasonal use were permitted to have septic systems with smaller leaching fields than required for year-round dwellings. When such homes are converted to all-season living, their septic systems are often overwhelmed by the increased use.

change. Until recently, villages like Buzzards Bay and Monument Beach had small year-round populations that were inflated in summer by seasonal residents and visitors. Now, however, the number of people who live in these villages is steadily increasing. The population of Falmouth, for example, tripled between 1950 and 1980.

With new housing and the conversion of summer homes to year-round dwellings, the increased population density brings new problems. Existing facilities such as roads, solid-waste disposal areas, water supplies, and septic systems are often inadequate to meet the higher demand. Residential growth is also accompanied by commercial development. With houses come stores, restaurants, and industry. All these uses place additional demands on utilities and introduce the problem of what to do with waste products, some of which may be toxic or hazardous.

Changes in the way land is used also involve less obvious problems. When land that was formerly undeveloped is covered with buildings, roads, or parking lots, soil and vegetation that absorb water from precipitation are replaced by surfaces that are impervious to water. Instead of soaking into the soil to recharge groundwater, precipitation now runs across the land, draining into streams and ponds and, through these, to the Bay. In addition, this runoff is no longer cleansed of pollutants by filtration through soil or uptake by plants.

Sources of Pollution

The priority issues identified from research conducted in Buzzards Bay are linked to development of the land around the Bay. Some of the major sources of pollution are discussed in the following sections.

Pathogen Contamination

Human waste contains a variety of bacteria and viruses, some of which are harmful, or pathogenic. Regulatory attention has traditionally focused on con-

In 1989, more than 12,000 acres of shellfish beds in Buzzards Bay were closed because of bacterial contamination.
Photo courtesy of the Lloyd Center for Environmental Studies.

trol of coliform (that is, intestinal) bacteria, based on standard tests for the presence of these indicator species. The presence of specific viruses and specific disease-causing bacteria is not measured because reliable, cost-effective tests to detect those organisms are not available. In the past two years, the Project has learned a great deal about sources of coliform bacteria:

- Stormwater runoff, carried through storm drains to the shores of the Bay, is an important cause of periodic closures of shellfish beds.
- Properly designed and functioning on-site sewage disposal systems do not appear to contribute significantly to bacterial contamination in the Bay.
- Levels of coliform bacteria are elevated in the area around marinas, whether or not pump-out facilities for boat heads are available, because not all boaters use these facilities.
- Freshwater streams entering the Bay generally have high concentrations of coliform bacteria, for reasons that have yet to be determined.
- Marsh sediments and deposits of beach wrack are a chronic, natural source of coliform contamination into the Bay.

Nutrient Enrichment

Groundwater is the primary source of nutrients to many embayments around Buzzards Bay. In developed areas, septic systems and fertilizers appear to be the major contributors of these nutrients. Effluent from New Bedford's sewage treatment plant is discharged directly into the Bay and is responsible for locally elevated concentrations of nutrients. Nutrient levels are considerably higher at the outfall site and in New Bedford inner harbor than in other parts of Buzzards Bay. Because more than 50 percent of the population discharges its sewage through this outfall, it is clearly the largest point source of nutrients in Buzzards Bay.

Agricultural land in the Buzzards Bay drainage basin also contributes to nutrient loading of the Bay. Research funded by the Buzzards Bay Project has shown that much of the fertilizer added to cranberry bogs is attenuated or removed within the bog, and nitrogen release is less than half that of developed land. This is significant because cranberries are a major crop in southeastern Massachusetts.

Toxic Contamination

Probably the largest single source of toxic contamination to Buzzards Bay is the Environmental Protection Agency Superfund Site in New Bedford Harbor. Highly toxic industrial compounds known as polychlorinated biphenyls (PCBs) were released into the harbor and Acushnet River estuary by manufacturing companies from about 1940 to the late 1970s. Although the discharges have stopped, the harbor is still contaminated with these long-lasting chemicals. High concentrations of PCBs accumulated in the sediment at the bottom of the harbor; as long as that sediment remains in place, it will continue to release PCBs into the water above it. Toxic metals such as copper, chromium, cadmium, zinc, and lead were also discharged to these waters by industry and are present in elevated concentrations in sediments.

In addition to PCBs and heavy metals, other chemicals of concern are pesticides, oil and other petroleum-derived compounds, and other substances on EPA's list of priority pollutants. Sources of these contaminants include combined sewer overflows (CSOs), agriculture, stormwater runoff, marinas, boat paint, landfills, and hazardous waste sites.

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Combined sewer overflows are common in older sewage systems such as the one in New Bedford. Their name comes from the fact that they carry both runoff water from storm drains and sanitary sewage. When flow is high due to heavy rain, the combined sewers can overflow, bypassing municipal sewage treatment plants and discharging raw sewage and its associated contaminants directly into the receiving body of water.

THE 1989 RESEARCH SYMPOSIUM

In February of 1989, the Buzzards Bay Project held its third annual symposium to discuss the results of its research. More than 100 people gathered in Woods Hole for each of the two days of meetings. The audience was diverse — scientists, regulators, environmentalists, interested citizens — and the discussion reflected the differing perspectives brought to bear on the issues. The speakers emphasized how their scientific findings relate to management questions revolving around the subjects of (1) closure of shellfish beds due to pathogen contamination, (2) nutrient enrichment, (3) toxic contamination of fish, lobster, and shellfish and its effects on humans, and (4) protection of living resources and habitat.

One fact that emerged from the discussion is that many of the issues are interconnected, making it difficult to discuss any one in isolation. As a result, management options overlap in complex ways, as illustrated by the subject of human waste, discussed below. The problem of how to treat it and what to do with its byproducts has clear implications for the problems affecting Buzzards Bay.

1. Closure of Shellfish Beds due to Pathogen Contamination

Buzzards Bay Project studies indicate that properly designed and functioning on-site disposal systems do a good job of keeping coliform bacteria out of ground and surface water. Management issues must also consider the control of viruses, which may behave differently than bacteria; the need to maintain adequate septic systems; and the effect of a predicted future rise in sea level on siting of such systems.

Properly functioning sewage treatment plants that provide at least secondary treatment also do a good job of removing bacteria. Management questions include where to locate the outfalls from these plants and how to pay for upgrading inadequate facilities and building new ones.

2. Nutrient Enrichment

Neither septic systems nor secondary treatment by municipal plants removes appreciable amounts of nitrate and phosphate from sewage. These nutrients can contribute to the decline of the waters into which they are discharged. This decline is reflected by turbid water, blooms of algae, lowered levels of oxygen dissolved in the water, and loss of beds of eelgrass. Management questions include how to regulate siting of septic systems so that nutrients are considered, where to site outfalls discharging effluent from municipal treatment plants to minimize nutrient enrichment of Bay waters, and whether sewage treatment plants are the best alternative along the coast.

3. Toxic Contamination of Fish, Lobster, and Shellfish and Effects on Humans

Sewage and industrial discharges can be a major source of toxic materials. When effluent from sewage treatment plants is discharged to a body of water such as Buzzards Bay, fish, lobster, and shellfish that live in the area can accumulate the chemicals, which are eventually passed on to humans. Management questions include how to determine safe levels of various chemicals and where to place treatment plant outfalls.

George Heufelder of the Barnstable County Health & Environmental Department was one of the speakers at the 1989 research symposium. He summarized what we have learned about pathogen contamination.

Photo courtesy of the Lloyd Center for Environmental Studies.

4. Living Resources and Habitat Protection

As already discussed, sewage can contribute to nutrient enrichment and toxic contamination. In turn, these two factors affect living resources and their habitat. Excess nutrients can lead to increased growth of phytoplankton, which inhibits growth of eelgrass by preventing the plants from getting enough light. Eelgrass provides valuable habitat for a variety of Buzzards Bay species. Toxic contamination can affect marine resources directly, as well as making them unsuitable for human consumption. Diseases and tumors in fish, lobster, and shellfish, for example, have been linked to toxic chemicals. The management questions already discussed regarding methods of sewage treatment and placement of treatment facilities thus also apply to the protection of living resources and habitat.

Additional Questions

The preceding example does not cover all the types of management questions for all problems. Some other significant questions that arose during the symposium are briefly listed:

- How will PCB contamination at the New Bedford Harbor Superfund Site continue to affect the Bay? Will most of the contaminated sediments be removed in clean-up efforts? How will they be treated to prevent further contamination? When, if ever, will the water in the harbor and Acushnet River estuary be clean enough for fishing and swimming?

- Although many toxic discharges are being decreased, materials have accumulated in the sediment and continue to be released. What is the role of sediments as a continuing source of toxic contamination?

- Freshwater streams, marinas (even with pump-out facilities), wrack line deposits, and marsh sediments are diffuse sources of coliform bacteria. How can these diffuse sources of bacteria be controlled?

- What is the best balance between development and high-quality resources?

- Where is the funding for the basic research needed to answer many of the questions going to come from?

- What role do taxes, assessments, and

fees have in land-use management?

- How can new scientific knowledge and technology be incorporated into the regulatory framework?

- How can sources of nitrogen be controlled in groundwater, which seems to contribute most of these nutrients to many embayments?

- What is the role of wetlands in controlling nutrient contributions to the Bay?

- How will the predicted rise in sea level affect coastal issues such as siting of septic systems and protection of wetlands?

- What methods can be used to monitor the Bay to see if remediation/control programs are working?

BUTTERMILK BAY STUDIES

Buttermilk Bay, an embayment at the north end of Buzzards Bay, has experienced periodic closures to shellfishing since 1984. At times, bacterial contamination in some areas of the bay has been high enough to close bathing beaches and restrict other forms of contact recreation. The Buzzards Bay Project has chosen to study this bay as a model for other embayments with similar problems.

The conditions in Buttermilk Bay illustrate the fact that much of the pollution in the area comes from small or diffuse sources that are not regulated by federal or state agencies. As a result, the responsibility falls to local government to control pathogen pollution by addressing issues such as failing or inadequately designed septic systems, storm drains, and boat wastes; and to limit nitrogen loading through growth management and advanced sewage treatment.

Pathogen Contamination

Stormwater

Stormwater discharge is the most important factor causing the periodic closure of Buttermilk Bay for shellfish harvesting. No sanitary sewage pipes were found to be connected to storm

Problems, including pathogen contamination and nutrient enrichment, in Buttermilk Bay are typical of those in many embayments.
Photo courtesy of the Lloyd Center for Environmental Studies.

Model for an Embayment Management Approach

The Buzzards Bay Project will use experience gained in its study of Buttermilk Bay to create management strategies for other embayments.

Step 1: Delineate the Watershed

The Project began by delineating the watershed that contributes water to the embayment. Buttermilk Bay has a 19-square-mile watershed that extends up to 8 miles inland from the bay. Much of the area is undeveloped, but there is considerable residential development on the shores of the bay.

Step 2: Catalog and Assess the Contamination Sources

In Buttermilk Bay, sanitary surveys were used to identify the sources of bacteria. The inventory included storm drains, failing septic systems, wildlife, marinas, and freshwater inputs such as streams and marshes. Sources of nitrogen entering the bay were quantified from land use, groundwater and stream loadings, and inputs from runoff and rainwater.

The Project then evaluated these sources to see how much pollution each contributed. Storm drains were found to be the major contributor of bacteria to Buttermilk Bay, and septic systems were the primary source of nitrogen.

Step 3: Conduct a Survey of Developable Lots

The Project is estimating, based on existing zoning requirements, how much growth will occur in the Buttermilk Bay watershed. This will forecast the amount of nitrogen that will enter the bay when the watershed is fully developed.

Step 4: Develop a Management Plan

The Buzzards Bay Project is working with the communities of Bourne, Plymouth, and Wareham to design a program to address pollution in Buttermilk Bay. Like all parts of the Comprehensive Conservation and Management Plan, this program will encompass a regulatory approach for controlling sources of contamination, a monitoring plan to assess results, and provisions for public participation. For Buttermilk Bay, recommendations will include actions to reduce fecal coliform inputs and nitrogen loading.

sewers, indicating that human waste is not the source of coliform bacteria in stormwater discharge. Road and land runoff carrying wastes from dogs and wildlife is probably the major source, supplemented by release of bacteria from sediments and beach wrack.

Fresh Water

Red Brook, one of the five freshwater streams that flow into the embayment, was investigated through field studies and review of historical data. Results confirmed that the brook is a consistent source of coliform bacteria, but no sources of pollution were identified. The most likely explanations are that septic plumes are entering the brook at places yet to be located, or that the adjacent large marsh increases the survival of the bacteria. The marsh may also be a natural source of other bacteria that interfere with tests.

Point Sources

Buttermilk Bay is a residential area and the Project identified only one point-source discharge, an effluent pipe coming from a local fish market. This outfall was determined to be a significant source of coliforms.

Beach Wrack

Beach wrack is made up of decaying eelgrass and other debris remaining after ebb tide. This material accumulates coliforms from animal waste and provides conditions that prolong the survival of the bacteria. The Project's laboratory experiments and field observations clearly showed that wrack can be a significant contributor to coliform levels in the bay.

Other Sources

Research on several septic systems in Buttermilk Bay showed that, in general, they are not a significant source of coliform bacteria. Likewise, studies failed to reveal an impact from marina operations in Buttermilk Bay. However, further research on this subject is needed.

Nutrient Enrichment

The Project found that groundwater and surface water transport nearly all the nitrogen entering Buttermilk Bay. Groundwater alone transports over 85 percent of the nitrogen load and most of this comes from septic systems. Leaching of fertilizer is the second largest source of nitrogen entering the embayment. Nitrogen loading rates in Buzzards Bay are moderately high and, within Buttermilk Bay, densely developed areas do exhibit signs of the adverse effects of over-enrichment. Overall, however, the embayment has a high flushing rate that has prevented widespread eutrophication from occurring to date.

THE BUZZARDS BAY ADVISORY COMMITTEE

The Buzzards Bay Advisory Committee (BBAC) is composed of representatives from communities around the Bay. This committee will be a major force in guiding the Project through the coming years. One of its major activities is to advise and assist on the local implementation of the Comprehensive Conservation and Management Plan, which is due next year.

In addition, this year the committee administered the Community Minigrant

In a ceremony at the Marion Town House, Steve Bliven (CZM), Steve Silva (EPA), and Ted Pratt (BBAC) awarded Minigrants to local communities.
Photo by Anne Smrcina.

Program to support local efforts at addressing priority issues in water quality, resource management, and land use. In a press conference held at the Marion Town House in July, the BBAC awarded seven grants totaling nearly $100,000. Eight communities (two of the grants were awarded jointly to more than one community) received funds in amounts from $5,000 to $25,000. The funded projects (described below) address many of the common issues around the Bay and are intended to serve as models for other towns facing similar problems.

- New Bedford and Fairhaven: Design a plan for pump-out facilities to handle septic wastes and used oil from vessels in the Acushnet River Harbor.

- Dartmouth: Delineate the Buttonwood Brook Watershed, document land uses in the watershed, and develop a management plan to improve water quality in the river.

- Acushnet, Rochester, and Marion: Establish a Regional Health District and hire a Regional Sanitarian to assist the towns in carrying out the requirements of state and local regulations for the disposal of wastewater.

- Wareham: Monitor boat traffic in its marinas, mooring areas, and launch ramps; circulate a questionnaire to collect data on boat use; and establish a grid system for moorings in the harbor.

- Fairhaven: Hold a series of seminars to educate town boards on their legal responsibilities and foster coordination between boards within and between towns.

- Westport: Eliminate marine wastewater discharges in the Westport River by establishing a pump-out facility for vessels in the harbor.

- Marion: Monitor water quality in its embayments for three years by using local volunteers to collect samples for analysis by certified laboratories.

PUBLIC OUTREACH

The Lloyd Center Curriculum

The Buzzards Bay Project believes that it is important to educate young citizens of the region about the Bay. As part of the public education program, the Lloyd Center for Environmental Studies, located in South Dartmouth, has developed a curriculum for use in local schools. Together with an Advisory Committee made up of teachers from regional schools, the Lloyd Center has identified three basic concepts the curriculum will stress:

- The Bay as a resource
- Problems threatening the Bay
- The role of the individual in protecting the Bay.

A group of teachers and Lloyd Center staff have collected and organized materials to be used in the curriculum.

Coalition Activities

The Coalition for Buzzards Bay is a nonprofit organization dedicated to educating and involving the public in saving the Bay. The Coalition was formed in July 1987; two years later its membership includes more than 400 concerned citizens and environmental groups.

The Coalition puts particular emphasis on informing people about practical ways in which they can contribute to a healthier and safer environment. In the past year the organization published articles urging residents to plant border vegetation near waterways to absorb nutrients that can cause pollution; explaining that dog feces are a serious factor in coastal water pollution; and suggesting ways for home gardeners to reduce their use of pesticides. The Coalition also produced a fact sheet discussing alternatives to toxic household chemicals such as drain and oven

The Coalition suggests that, instead of using caustic drain cleaners, we should get in the habit of pouring boiling water down drains each week. If a blockage does occur, use a mix of 1 cup baking soda, 1 cup salt, and 1 cup white vinegar. Wait 15 minutes, then flush with boiling water.

cleaners and listing approved ways to dispose of items such as leftover paint and motor oil.

On the theory that pictures are often more eloquent than words, the organization has assembled a traveling photo exhibit of pictures taken around the Bay by students at Southeastern Massachusetts University. A slide show is also in the works.

Other highlights of the Coalition's work in the past year are summarized below:

- Buttermilk Bay Public Education Project

In response to a grant from the Environmental Protection Agency, the Coalition embarked on a year-long project to reach the public in innovative ways. In one major effort, summer interns distributed educational materials door-to-door around Buttermilk Bay.

- Environmental Report Cards

The Coalition filled out environmental report cards for 12 municipalities in the watershed. These cards rated the communities on their effectiveness in protecting groundwater and coastal water.

- Oil Spill Response Meeting

In June the Coalition co-sponsored a Cape Cod meeting aimed at better coordination of response to possible oil spills in the Bay. Congressman Studds and State Senator Rauschenbach were the other sponsors.

- Other Activities

The Coalition held a forum on zoning variances and the role of local Boards of Appeals, helped organize an Adopt-a-Stream meeting, manned a booth at many local events, and issued monthly State-of-the-Bay Reports on the number of shellfish beds closed around the Bay.

ISSUES WORKSHOPS

During the summer and fall of 1989, the Project conducted Issues Workshops to prepare for production of the Comprehensive Conservation and Management Plan. The series of five workshops was based on the scientific findings generated by the Project. The objective was to give scientists, state and federal regulators, the public, and especially town officials the chance to express their opinions on management options to address the Bay's problems. This is important because the recommendations in the CCMP will be implemented mainly at the local level and demand the support and participation of local Conservation Commissions, Boards of Health and Planning, Selectmen, City Councilors, and citizens around the Bay.

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Issues Workshops and Moderators. For each workshop a moderator framed the issues in the proper management context and a panel of experts joined the audience in discussing the management options. The Project hoped that a consensus would emerge so that the preferred options can become a part of the CCMP.

Growth Management	Jon Witten, President, Horsley Witten and Hegeman, Inc.
Wetlands & Habitat Protection	Mark Robinson, Executive Director, The Compact of Cape Cod Conservation Trusts, Inc.
Shellfish Protection	George Heufelder, Senior Public Health Sanitarian Barnstable County Health and Environmental Department
Toxics & Hazardous Wastes	Judith McDowell-Capuzzo, Senior Scientist Woods Hole Oceanographic Institution
Sewage Treatment Options	Jan Smith, Water Quality Specialist Massachusetts Office of Coastal Zone Management

DIRECTIONS AND APPROACH

In 1990, the Buzzards Bay Project will become one of the first estuaries in the National Estuary Program to have completed a Comprehensive Conservation and Management Plan (CCMP). All estuaries in the national program are required to produce such a blueprint for restoring and protecting the estuary. The CCMP will define the most important problems and establish goals and objectives for resolving them. The CCMP will contain recommendations to local, state, and federal agencies for control of pollution, regulation of land uses within the watershed, and management of marine and coastal resources. These recommendations must be specific and, above all, practical — unless they can be carried out, they are useless.

Both the National Estuary Program and the Buzzards Bay Project stress the importance of implementation of the management plans in the CCMP. The plan must not only include recommended actions, but also identify who will carry out these actions and how they should be paid for. In addition, it must establish a schedule for compliance.

The Project's various advisory committees are guiding the preparation of the CCMP. They will use the research conducted as part of the study in developing recommendations and will rely on the workshops the Project held in the summer and fall of this year to gauge public support for possible recommendations.

THE ACTION PLANS

The Buzzards Bay Comprehensive Conservation and Management Plan will consist of specific plans of action to address the priority issues affecting water quality and living resources in Buzzards Bay. These action plans are the core of the CCMP.

Each action plan will begin by summarizing the issue, giving scientific and technical information as background, and reviewing past management strategies. The action plan will identify management objectives for achieving a preferred goal and identify specific options for accomplishing the objective. Implementation will include a schedule that specifies when actions will be put into practice. The action plan will also identify the lead organization to oversee the recommended actions, what agencies or groups must be involved, and how they should interact. The final section of the action plan will identify strategies for financing the actions.

Action plans for the priority issues are still in the development stage. A sample plan addressing nutrient enrichment is presented here (see the following page). This is purely for illustration; the sample plan has not been discussed with the appropriate agencies. In addition, some other possible subjects for action plans are briefly described.

In the course of its research, the Project has come to realize that many of the problems that plague the Bay are localized. The Bay is made up of many small embayments, each with its own set of physical conditions and surrounding environments. For example, an embayment containing a busy marina and surrounded by residential development will have different problems than one that has little boat traffic and is surrounded by dairy farms. Furthermore, an embayment with a high rate of tidal flushing will react differently than one that is poorly flushed. Many of the recommendations of the CCMP will thus focus on individual embayments.

MANAGING NITROGEN-SENSITIVE EMBAYMENTS (DRAFT)

The Problem

In Buzzards Bay, as in most coastal areas, nitrogen is the nutrient that usually limits the growth of algae (which include both macroalgae, or *seaweeds*, and microalgae such as phytoplankton, which form the base of many marine food chains). Increased supplies of nitrogen threaten many embayments within Buzzards Bay by stimulating blooms of both. These blooms can limit the transmission of light reaching eelgrass leaves, resulting in loss of eelgrass beds which provide habitat for shellfish and other animals. Dense layers of macroalgae accumulate on the bottom of some shallow bays and exclude shellfish and other invertebrates, destroying valuable habitat. In addition, decay of the macroalgae causes unpleasant odors and depletes oxygen in the water. Severe oxygen depletion can kill fish and shellfish. There is also evidence that nutient loading promotes (directly or indirectly) the survival of coliform bacteria and contributes to closure of shellfish areas. Overall, nitrogen loading is one of the most serious long-term impacts threatening many embayments around Buzzards Bay.

Background

- Septic systems do not adequately remove nitrogen-containing compounds before they reach groundwater. This is the primary source of additional nitrogen in many embayments.
- Contributions of nitrogen from current and future land uses can be estimated.
- Some local governments use nitrogen loading as a management tool.
- Because of differences in flushing rates, depth, and relative sizes of drainage basins, embayments vary in the amount of nitrogen they can tolerate without adverse effect. This leads to the concept of nitrogen-sensitive embayments to describe those that have a low tolerance for additional nitrogen.

Issues

- It is costly to upgrade existing municipal treatment plants to remove nitrogen from sewage.
- On-site septic systems that remove nitrogen are still considered experimental and are not allowed in Massachusetts. Most systems tested have produced mixed results, and may be expensive or fraught with maintenance problems.
- The role that state and local governments play in managing nitrogen loading is not well defined.

Goals

The following goals apply to embayments with resources that are of significant value ecologically or economically.

- Ensure that no beneficial water uses will be lost, nor will ecosystems be adversely affected by excessive contributions of nitrogen to any embayment within Buzzards Bay.
- Restore any beneficial water uses and ecosystems lost or impacted by the excessive contribution of nitrogen to any embayment within Buzzards Bay.

Management Objectives and Actions for Achieving Goals

- Develop nitrogen-loading limits for all nitrogen-sensitive embayments to prevent degradation of water quality or ecosystem health.
- Delineate drainage basins and flushing rates for embayments in Buzzards Bay.
- Develop approved methods for conducting build-out and nitrogen-loading analyses.
- Conduct nitrogen-loading assessments to determine how much nitrogen each embayment receives now and will receive in the future.
- Encourage towns to adopt nutrient-loading bylaws and plan growth around nitrogen-sensitive embayments to meet nitogen-loading rate limits.
- Provide towns with technical assistance in the use of the methods discussed above.
- Foster development and use of cost-effective alternative technologies for nitrogen removal.
- Promote cost-effective public and private advanced sewage treatment facilities with the capacity to remove nitrogen.
- Monitor nitrogen-sensitive embayments to document effectiveness of management actions.

Strategy

A program for limiting the amount of nitrogen entering nitrogen-sensitive embayments should be enacted at both municipal and state levels. Generally speaking, for the municipalities, this will require greater recognition of future growth conditions and requisite land-use desisions. At the state level, the Department of Environmental Protection should incorporate nitogen-loading rate limits into the state's surface water quality standards to prevent environmental degradation, and should conduct a water quality monitoring program in support of this strategy. Implementation of nitrogen-loading rate limits in the surface water quality standards will also allow the state to require compliance by municipalities who fail to take steps to protect outstanding resource areas.

Lead Responsibility

Initially, the Buzzards Bay Project will promote the implementation of the recommended actions, with the cooperation of state and local agencies.

Financing*

The Buzzards Bay Project will work with DEP and the scientific community to identify the appropriate nitrogen-loading limits for nitrogen-sensitive embayments. The Buzzards Bay Project will assume the costs of delineating drainage basins, calculating flushing rates, and conducting some of the nitogen-loading assessments. The Department of Environmental Protection, local communities, and contractors could finance monitoring in support of this strategy in subsequent years. Federal, state, and local sources of funding will be identified to conduct land-use assessments to continue this program.

** This is a sample draft action plan; cooperating agencies have not yet agreed to any components.*

Stormwater Runoff

Stormwater runoff is one of the most important causes of bacterial contamination leading to shellfish bed closures in Buzzards Bay. When it rains, runoff from street drains flushes pathogens from animal wastes, failing septic systems, and other sources into the Bay. Storm drains also carry toxic chemicals, including oil and heavy metals from highways, and pesticides and nutrients from home gardens and commercial agriculture. A number of possible management options could be designed to alleviate this situation:

- Construct catchment facilities to remediate existing stormwater discharges that flow directly into the Bay. Two such structures are being tested in Buttermilk Bay. The objective is to ensure that the water percolates naturally through the soil before it reaches a body of water.

- Recommend that local communities adopt regulations making pet owners responsible for cleaning up after their animals. Combine this with an education campaign to make the public aware of the role of animal feces in water pollution.

- Prevent the construction of any new street-drain outfalls that discharge directly into coastal areas.

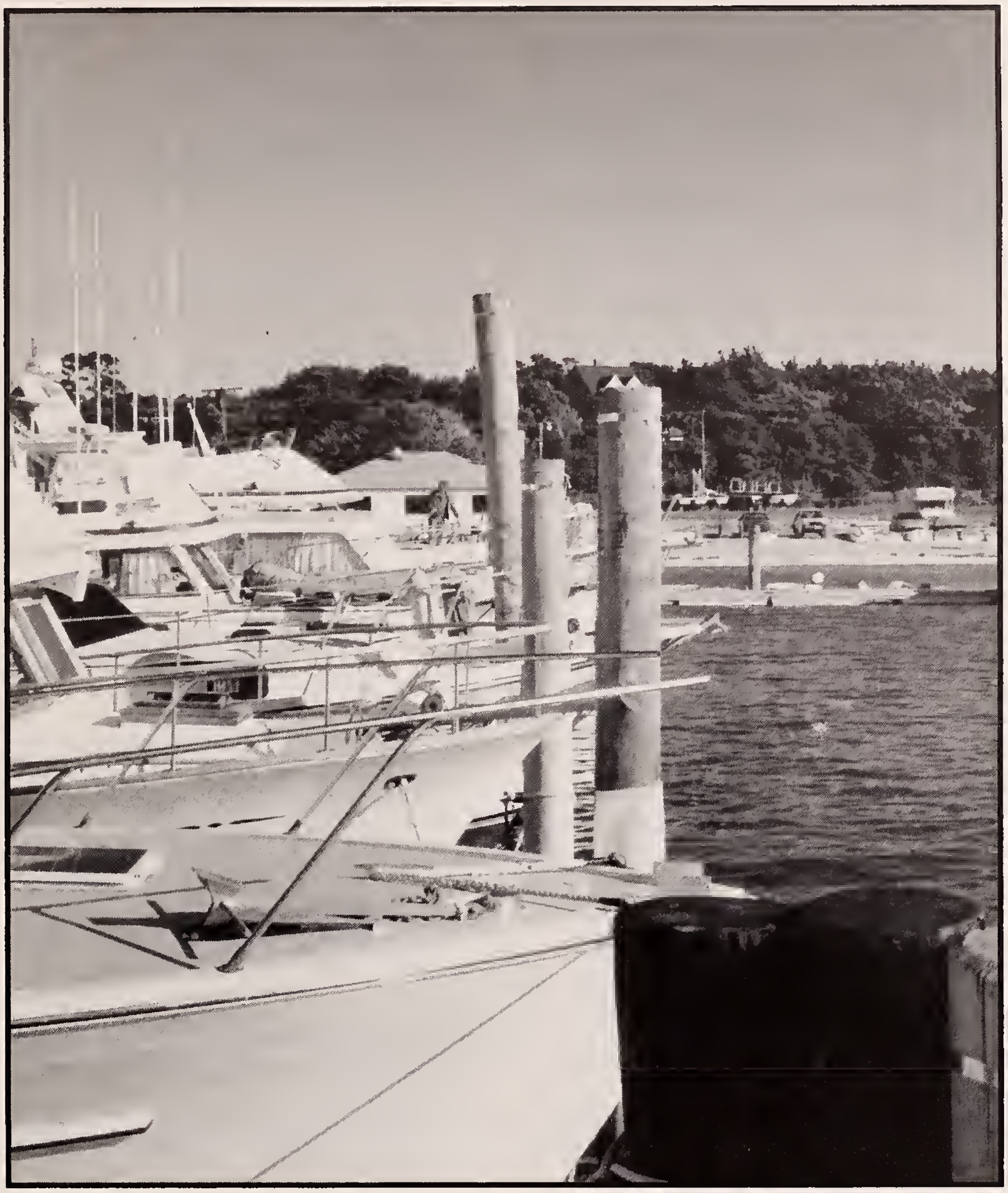
Marinas

Bacteria associated with the operation of marinas are also a source of contamination. Management options could emphasize ways to get boaters to use pump-out facilities to dispose of wastes from marine toilets. Actions could include constructing more such facilities and encouraging their use by reducing or eliminating fees. Harbor Masters and health agents could prohibit discharge to harbors by a system of sealing heads or plugging discharge ports on boats and by local enforcement of these measures. Public education should be an important component of the plan. A plan to manage the disposal of boat septage could also be developed.

Seafood Testing

Research sponsored by the Project has shown that the tissues of shellfish, lobster, and flounder throughout the Bay

An action plan to address stormwater runoff will be an important part of the Comprehensive Conservation and Management Plan.
Photo courtesy of the Lloyd Center for Environmental Studies.



To help reduce bacterial contamination, marinas around the Bay should provide facilities for pumping marine toilets, and boaters should use them.
Photo by Victoria Gibson.

have accumulated PCBs and other toxic chemicals, especially near New Bedford. Sources of these contaminants include CSOs, agriculture, stormwater runoff, marinas, landfills and hazardous waste sites, and direct discharges. Human consumption of PCB-contaminated seafood is a possible health risk. The Buzzards Bay Project is considering an action plan to monitor seafood in the Bay for PCBs and other toxic chemicals. A related action could address the fact that at present there are differences of opinion about how to test for toxic contamination in fish and shellfish tissues; how to interpret the scientific findings; and, in some cases, at what levels a chemical presents a risk to consumers. The CCMP might well recommend that standard methods and criteria be developed.

Point Source Discharges

In some cases, industrial and municipal facilities discharge wastewater directly to Buzzards Bay. These are known as point source dischargers and must apply for permits under the National Pollutant Discharge Elimination System (NPDES). About 30 such permits have been granted to facilities around the Bay. An action plan aimed at reducing toxic materials from these discharges could include these recommendations:

- Revise the conditions in the NPDES permits to be more restrictive.

- Enforce an inspection schedule to verify that facilities are complying with the conditions of their permits.

- Provide incentives to industries for reducing their discharges.

Household Chemicals

Individual residents use hazardous chemicals such as house and garden pesticides, paint and paint thinners, motor oil, and an assortment of cleaning agents. Excessive use and improper disposal of these chemicals contributes to toxic contamination in the Bay. An action plan aimed at households would probably include programs of hazardous waste collection by local communities and would emphasize public education. The Coalition for Buzzards Bay has already done outstanding work in producing educational materials on this subject.

Oil Spills

Oil spills in the Cape Cod Canal and the Bay have occurred frequently enough in the past to represent a significant source of pollution. The following recommendations are being considered as part of an oil spill and oil pollution action plan: update and distribute regional contingency plans, appoint and train municipal oil-spill coordinators, maintain inventories of cleanup equipment, schedule regular interagency training drills, upgrade storm drains with catchment basins and oil traps to reduce chronic inputs, acquire and maintain onsite cleanup equipment (booms, absorption materials) for local response until state and federal authorities arrive.

Other Options for Action Plans

Other action plans could be directed at reducing bacterial loads in freshwater streams, decreasing the number of combined sewer overflows in the New Bedford area, increasing the number of houses connected to sewers, and instituting water testing methods that measure pathogens directly instead of relying on indicator organisms.

THE MONITORING PLAN

In the coming year the Buzzards Bay Project will develop a monitoring plan for Buzzards Bay. This plan will be used to evaluate long-term water quality trends in the Bay and to determine whether the management practices put into effect are protecting and improving the Bay's water quality and living resources. The plan, which will become part of the Comprehensive Conservation and Management Plan, will guide future monitoring efforts conducted by state agencies and by the Project.

The plan will be based on available information and recommendations generated by the Project, on existing plans in effect in the Bay, and on similar plans implemented elsewhere in Massachusetts and in other estuaries in the National Estuary Program. The plan will involve a number of tasks, which are described in the following sections.

Baseline Information

The current state of pollutants entering Buzzards Bay will be determined. Existing data on the sources of pathogens, nutrients, and toxicants will be acquired from local, state, and federal agencies, and other available sources. This information will be synthesized to provide a baseline against which future monitoring data can be compared.

Existing Monitoring Programs

A variety of local, state, and federal agencies, academic institutions, and other organizations collect data of different kinds in Buzzards Bay. The object of this task is to identify these programs and find out what is being measured, where, how often, and by what methods. This will make it possible to evaluate how existing programs can be used to help meet the goals of the monitoring program.

Monitoring Strategy

A scientifically valid monitoring plan must be designed to answer specific questions that must be defined before any samples are taken. The monitoring strategy — what to measure, where, and how often — is built around the questions to be answered.

Monitoring Methods

The Buzzards Bay Project's research has clearly shown the importance of using consistent methods for collection and analysis of samples. When the Project evaluated data collected in the past, it found that, in many cases, results from different areas or times could not be compared because the results were obtained in different ways. In developing the monitoring plan, methods for all phases of the monitoring effort will be evaluated, and a set of standard methods recommended.

Contents of the Monitoring Plan

The monitoring plan will specify when and where samples will be taken for water quality, sediment chemistry, and physical measurements. It will make recommendations for when, where, and how to monitor living resources to assess changes in the health of areas of the Bay. Living resources include salt marshes, eelgrass beds, shellfish, finfish, sea birds and waterfowl, and benthic invertebrates.

As part of state and federal programs, towns around the Bay monitor concentrations of bacteria at bathing beaches each month. If necessary, the monitoring program will recommend supplements to these efforts.

The plan will also contain a citizens monitoring component. It will identify ways in which the public can assist in monitoring, what organizations will coordinate the effort, and where the resulting data should be stored.

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Water quality and living resources in Buzzards Bay will be monitored to assess the effectiveness of the CCMP's recommendations.
Photo courtesy of Battelle Ocean Sciences.

NEXT STEPS FOR THE PROJECT

Once the Comprehensive Conservation and Management Plan is completed, the Project's work will continue; implementation of the CCMP will be an ongoing process.

A Memorandum of Understanding is a document through which participating agencies agree that they will coordinate their activities with one another in a particular subject area.

STATE IMPLEMENTATION AND INTERAGENCY AGREEMENTS

The CCMP will be incorporated into the Commonwealth's Coastal Zone Management Plan. In light of this fact, preparation of the management plan is a multiphase process:

1. Draft the CCMP with attention to coastal zone management policies and goals.

2. Submit the CCMP to the Massachusetts Office of Coastal Zone Management (CZM) for a formal review of its consistency with the federally approved CZM Plan.

3. Incorporate the CCMP into the CZM plan so that it becomes official state policy.

4. Negotiate Memorandums of Understanding (MOUs) between the federal and state agencies that have jurisdiction over activities recommended by the CCMP.

Quahogging is a traditional activity, both commercial and recreational, around Buzzards Bay. With the Project's help, this and other uses of the Bay will be preserved for the future.
Photo courtesy of the Lloyd Center for Environmental Studies.

5. Submit the amended CZM plan (incorporating the CCMP) to the National Oceanic and Atmospheric Administration for approval.

Massachusetts is fortunate in having a ready-made vehicle to review and adopt the CCMP through a highly centralized coastal zone management program. At this writing, the Environmental Protection Agency is developing a process for the CCMP consistency review and for approval on the federal level. This process will be incorporated into the phases listed above.

LOCAL IMPLEMENTATION

The local nature of much pollution shows why it is important that municipalities be involved in and supportive of the management options in the CCMP. Local boards and commissions responsible for zoning, subdivision control, and health regulations have considerable power to regulate and protect the coastal environment. It is likely that they will be charged with implementing many actions included in the CCMP. Broad public understanding and support of the recommendation is also crucial for two reasons. First, the management actions are inextricably linked with the daily activities of residents in the watershed. Second, citizens must make some financial commitment to pay for the actions.

THE FINANCIAL MANAGEMENT PLAN

Environmental management costs money. As part of the CCMP, the Buzzards Bay Project is developing a financial management plan to identify ways to pay for the recommendations in the action plans. The financial plan will be formulated in two phases:

1. Conduct a public finance inventory to identify and evaluate federal, state, and regional funding sources. This step will be finished in time to be included in the draft CCMP scheduled for completion during the spring of 1990.

2. Choose the funding sources that best match the management actions. This step will be included in the revised and refined CCMP.

Each phase includes plans for outreach efforts to inform the public of the financial considerations involved in protecting the Bay. In the second phase, the outreach will strive to make citizens and public officials aware of the tradeoffs between financial and environmental decisions.

FUTURE ACTIVITIES

Two future activities already discussed are the implementation of the CCMP action plans and the program to monitor the effectiveness of these actions. A third area in which work will continue is the modification of the CCMP.

One of the strengths of the CCMP as a management tool is its flexibility — it can change and adapt. Revisions could be necessary for a variety of reasons: some recommendations may not be working as well as expected; new information may become available, making it necessary to reevaluate choices; advances in technology may result in new, more efficient approaches; resources may become available for addressing additional issues.

Problems in estuaries like Buzzards Bay are complex and cannot be solved overnight. The project will work hard in the coming years to carry out the recommendations of the CCMP. Only with the solid support of citizens around the Bay and the assistance of state and local government will we be able to preserve this valuable resource.

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PROJECT ORGANIZATION

The organization of the Buzzards Bay Project includes the groups that are committed to the support and implementation of any resulting recommendations. These groups are key constituents for the Project's success. They include members from the research community, public interest groups, local officials, and state and federal resource managers.

Policy decisions, project management, citizen involvement, and technical advice are all necessary components of a successful Buzzards Bay Project. To accommodate the variety of interests and expertise, organizations, perspectives, and agendas, the Project is organized into five committees that bring together people concerned with the differing aspects of a comprehensive estuarine management program. Each committee has a role that interrelates with other committees so that Project plans can be systematically reviewed and evaluated.

Policy Committee

The Policy Committee sets the overall policy of the Buzzards Bay Project and ensures that a coordinated federal-state effort is made to address resource management decisions in the Bay. The Policy Committee is composed of the Regional Administrator of U.S. Environmental Protection Agency Region I and the Secretary of the Executive Office of Environmental Affairs of the Commonwealth of Massachusetts.

Management Committee

The Management Committee directs program activities for the Buzzards Bay Project. It formulates a long-range strategy for the management of Bay resources and develops annual work plans for research, monitoring, and pollution control. Membership includes a representative from each of the state and federal agencies or regional planning commissions that have responsibility for coastal environmental quality in and around the Bay.

Technical Advisory Committee

The Technical Advisory Committee (TAC) serves as a forum for technical expertise on Buzzards Bay. Membership is drawn from the academic institutions and agencies around the Bay that are active in research, monitoring, and resource assessment. The TAC reviews annual work plans, research proposals, and research results, and provides technical direction to various projects.

Buzzards Bay Advisory Committee

The Buzzards Bay Advisory Committee (BBAC) will help develop and implement the Comprehensive Conservation and Management Plan for the Bay. The group is composed primarily of town and state officials. In addition to its work on the management plan, the BBAC performs a variety of other functions:

- Facilitates regional communication and cooperation among municipal and state and federal agencies concerned with the management of Buzzards Bay and its watershed by discussing water quality concerns in their communities.

- Takes advantage of the Buzzards Bay Technical Assistance Program through which staff of the Massachusetts Coastal Zone Management Office assist local boards on water quality issues.

- Helps Buzzards Bay communities solicit funds for pollution control projects through programs such as the non-point source bill, transportation bond issue, proposed coastal research and monitoring program, and Buzzards Bay Project grants program.

- Serves as a political force to solicit continued funding for water quality projects from both state legislators and congressional delegates.

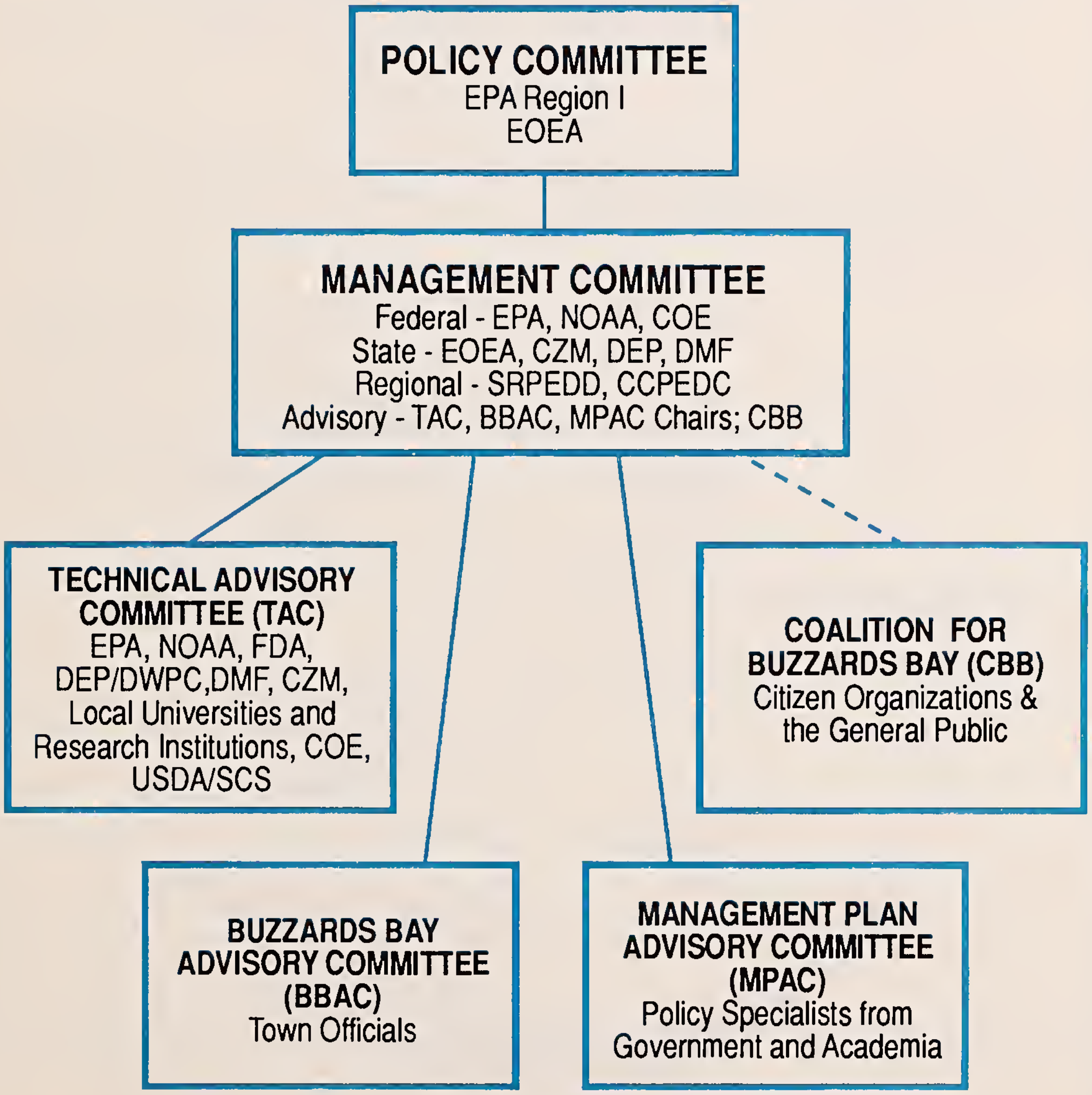
Management Plan Advisory Committee

The newly formed Management Plan Advisory Committee (MPAC) consists of administrators and marine policy specialists from local, state, and federal agencies and from academia. Its primary function is to assist with implementation of the Comprehensive Conservation and Management Plan at the state and federal levels and to help develop the action plans in the CCMP.

The Coalition for Buzzards Bay

The Coalition for Buzzards Bay is an independent group that works to increase the awareness of citizens and communities surrounding the Bay about water quality and land use in the area. The Coalition advises, informs, and collaborates with local, state, and federal agencies responsible for environmental quality in Buzzards Bay. The nonprofit organization includes more than 400 members from research institutions, businesses, citizen and environmental organizations, and the general public.

BUZZARDS BAY MANAGEMENT STRUCTURE


POLICY COMMITTEE
EPA Region I
EOEA
MANAGEMENT COMMITTEE
Federal - EPA, NOAA, COE
State - EOEA, CZM, DEP, DMF
Regional - SRPEDD, CCPEDC
Advisory - TAC, BBAC, MPAC Chairs; CBB
TECHNICAL ADVISORY COMMITTEE (TAC)
EPA, NOAA, FDA, DEP/DWPC,DMF, CZM, Local Universities and Research Institutions, COE, USDA/SCS
COALITION FOR BUZZARDS BAY (CBB)
Citizen Organizations & the General Public
BUZZARDS BAY ADVISORY COMMITTEE (BBAC)
Town Officials
MANAGEMENT PLAN ADVISORY COMMITTEE (MPAC)
Policy Specialists from Government and Academia

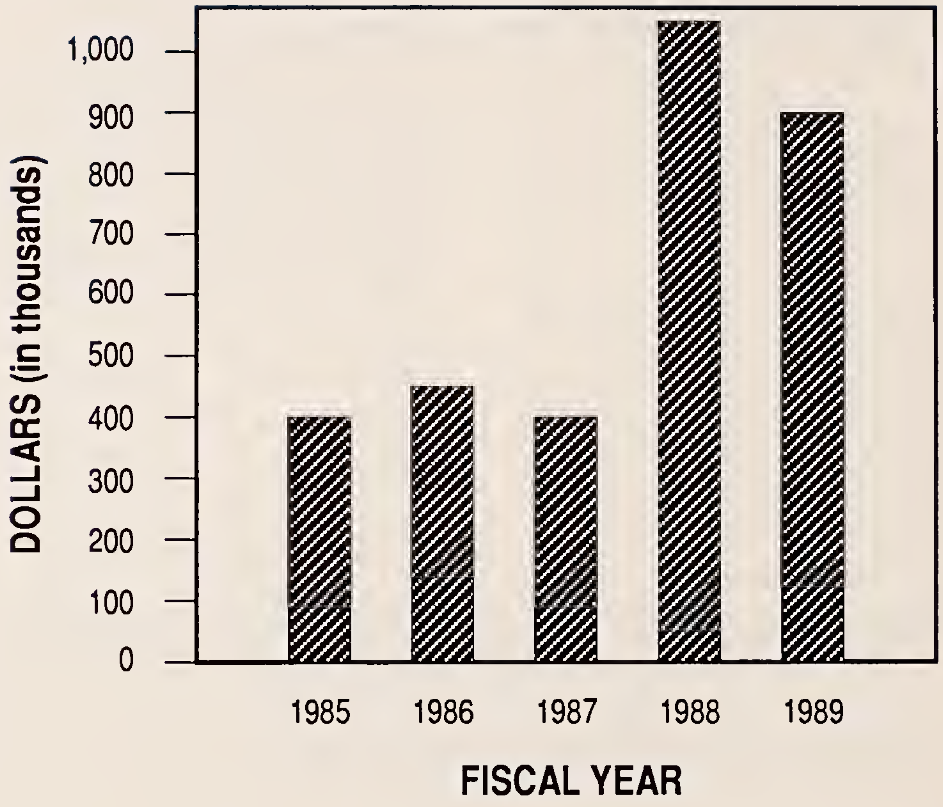
ORGANIZATIONS LISTED:

CCPEDC	Cape Cod Planning and Economic Development Commission
COE	U.S. Army Corps of Engineers
CZM	Massachusetts Coastal Zone Management
DEP	Massachusetts Department of Environmental Protection
DMF	Massachusetts Division of Marine Fisheries
DWPC	Division of Water Pollution Control
EOEA	Massachusetts Executive Office of Environmental Affairs
EPA	U.S. Environmental Protection Agency
FDA	U.S. Food and Drug Administration
NOAA	National Oceanic and Atmospheric Administration
SRPEDD	Southeast Regional Planning and Economic Development District
USDA/SCS	U.S. Department of Agriculture, Soil Conservation Service

BUZZARDS BAY PROJECT FUNDING

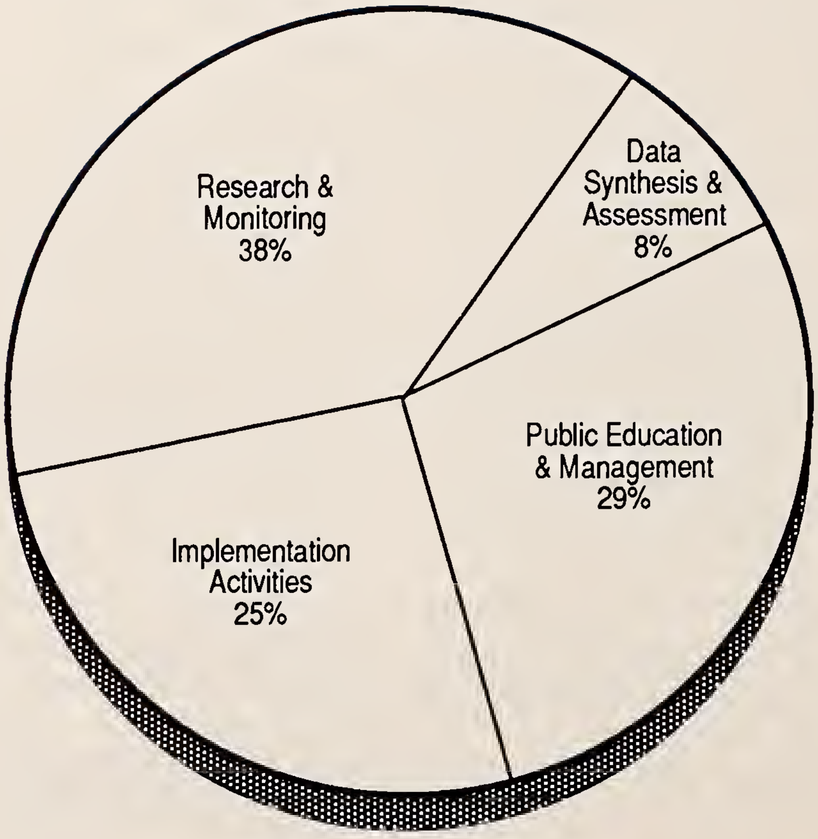
Before 1988, the Buzzards Bay Project received most of its funds from the federal government. Now, however, the Commonwealth of Massachusetts provides at least 25 percent of the Project's annual budget.

ANNUAL FUNDING



Since 1985, the Project's annual funding has more than doubled.

1989 FUNDING ALLOCATION



In 1989, funds for the Project were allocated to four principal activities.

BUZZARDS BAY PROJECT REPORTS

The reports listed here have been approved by the Buzzards Bay Project and are available from the Lloyd Center for Environmental Studies, 430 Potomska Road, Box 7037, South Dartmouth, MA 02748 (phone 508/990-0505). Other reports are in preparation or under review by the Project.

Southeast Regional Planning and Economic Development District. Inventory of Local Regulations. No. BBP-88-01.

Alber, M. Shellfish in Buzzards Bay. No. BBP-88-02.

Heufelder, G. Bacteriological Monitoring in Buttermilk Bay. No. BBP-88-03.

Heufelder, G. Survival and Transport of Enteric Bacteria and Viruses. No. BBP-88-04.

Costa, J. Eelgrass in Buzzards Bay. No. BBP-88-05.

Battelle Ocean Sciences. Identification and Collection of Historical Data for Buzzards Bay: Volume 1. No. BBP-88-06.

Battelle Ocean Sciences. Summary of Existing Literature for Buzzards Bay. No. BBP-88-07.

Battelle Ocean Sciences. Water Quality Data Assessment. No. BBP-88-08.

Battelle Ocean Sciences. Identification and Collection of Historical Data for Buzzards Bay: Volume 3 (Interview Sheets). No. BBP-88-09.

Moog, P. Hydrogeology and Fresh Water Influx of Buttermilk Bay. No. BBP-88-10.

Southeast Regional Planning and Economic Development District. Technical Resource Manual. No. BBP-89-11.

Southeast Regional Planning and Economic Development District. Sample By-Laws. No. BBP-89-12.

Southeast Regional Planning and Economic Development District. Assessment of Past Implementation of Local Water Quality Recommendations. No. BBP-89-13.

Massachusetts Department of Environmental Quality Engineering. Buzzards Bay Water Quality Data Report (1985). No. BBP-89-14.

Massachusetts Department of Environmental Quality Engineering. Buzzards Bay Sediment Data Report. No. BBP-89-15.

Massachusetts Department of Environmental Quality Engineering. Buzzards Bay Water Quality Data Report (1986). No. BBP-89-16.

Butman, B. Current Observations on Buzzards Bay. No. BBP-89-17.

Fish, C. Computer Enhanced Modelling of Tidal Velocities and Circulation Patterns in Buttermilk Bay. No. BBP-89-18.

Massachusetts Department of Environmental Quality Engineering. Bacteriological Data (Microbial Indicators). No. BBP-89-19.

Valiela, I. and J. Costa. Eutrophication in Buttermilk Bay. No. BBP-89-20.

FURTHER INFORMATION

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Cover
Land-use data courtesy of MassGIS; thanks to Neil MacGaffey, Mike Terner, and Deb Cohen.

The map on the front cover depicts land use in the Buzzards Bay drainage basin. The drainage basin boundary does not coincide with town boundaries, and unmapped areas within the drainage basin represent town land use not yet entered into the database. Compare to map on page 2.

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